27

62950

NEW BEDFORD HARBOR EXPOSURE ASSESSMENT

DRAFT

Prepared by:

TERRA, Inc.

October 1989

Table of Contents

Table of Contents (continued)

1.0 OBJECTIVES

The objectives of this report were to characterize exposures to PCBs which may occur as a result of contact with sediment during beachcombing or shellfishing activities and from the ingestion of fish and shellfish caught from banned areas.

There is insufficient data to adequately characterize actual exposures to PCBs via direct contact with sediments or by ingestion of fish caught from banned areas. As such, it is necessary to make assumptions regarding the level of human contact with sediment and judgements concerning the level of fish intake by persons who may ignore the fishing ban. Where assumptions are made, reasoning to support the assumption is also supplied. It is important that exposure assumptions conservatively though realistically predict exposure without grossly overestimating PCB intake, as any overestimation of exposure will necessarily lead to exaggeration of risk.

2.0 BEACHCOMBING AND SHELLFISHING EXPOSURE SCENARIOS

Although there is no direct evidence to suggest that contact with sediments has produced increased PCB body burden in any group of persons, there is existing information which suggests that contact with sediments containing PCBs may occur. Evidence of human activity has been reported along one shore of the Upper Estuary (Leonard Sarapas, Balsam Environmental Consultants, Inc., 1989, personal communication), indicating that exposure could occur during beachcombing or shellfishing activity. This scenario assumes only direct contact with sediment and does not account for PCB intake which could occur from ingestion of clams taken from these areas. PCB exposure resulting from ingestion of seafood is addressed under the seafood consumer exposure scenario.

The Draft Final Baseline Public Health Risk Assessment; New Bedford Harbor Feasibility Study (Ebasco, 1989) divided areas where direct contact with sediment could occur into Areas I, II, and III. Area I includes the area between the Wood Street and Coggeshall Street bridges. This area includes the Upper and Lower Estuary of the Acushnet River and the Cove Area. Area II included the area between the Hurricane Barrier and the Coggeshall Street Bridge and the following specific areas: Palmer Island, Popes Island, and Marsh Island. Area III is defined as the area south of the Hurricane Barrier and includes the Fort Rodman and Fort Phoenix Beach Areas. The present report also uses these defined areas to assess possible direct human exposure to sediment.

Exposure scenarios for Areas I, II, and III include older children (7 to 16 years of age) and adults who may be exposed to PCB in sediment. Beachcombing exposure was considered plausible for both the older child and adult in Areas I, II, and III. The beachcombing exposure scenario assumes sediment exposure which is typical of walking on a mud flat or sandy beach.

In addition to the adult and older child, a young child (1-5 years of age) was also considered as a possible receptor for Area III.

Shellfishing was considered to be a potential activity for adults and older children in Area I. The shellfishing exposure scenario assumes considerably greater contact with sediment than the beachcombing scenario since shellfishing may require digging and kneeling in sediment.

2.1. Exposure Variables

Variables for the beachcombing and shellfishing scenarios for Areas I, II, and III are listed in Table 2-1 and reviewed below.

2.1.1 PCB Concentrations in Sediment

2.1.1.1 Area I

Human accessibility to sediments guided the selection of appropriate PCB sediment concentrations for estimating exposure. Mud flats in the Upper Estuary were considered areas in which beachcombing and shellfishing (and therefore, PCB exposure) was likely to occur. PCB sediment concentrations ranging from 0 (assumed to be below detection limits) to over 100,000 ppm have been reported (Figure 2B, Hot Spot Sediment Distribution, Hot Spot Feasibility Study, New Bedford Harbor, EPA, 1989). In particular, "hot spots" in the Upper Estuary have been shown to have PCB concentrations above 4000 ppm. However, the possibility of beachcombing or shellfishing activity at these locations is remote, given that these areas are typically underwater and incapable of fully supporting a person's weight (Personal communication, Leonard Sarapas, Balsam Environmental Consultants, Inc., July 1989). Industrial development, fencing, and bulkheading, in addition to the relative lack of sandy deposits on the western shore of the Upper Estuary also make contact with sediments on that side of the estuary unlikely. If exposure to sediment does occur, it is much more likely that it will occur on the eastern side of the Upper Estuary, in the Lower Estuary, and in the Cove Area.

A PCB sediment concentration of 300 ppm was chosen as a representative concentration for PCBs in Area I. With the exception of the northern portion of the eastern side of the Upper Estuary and western side of the Upper Estuary, concentrations of PCBs in mudflat areas tend to be below 300 ppm. As stated above, the western side of the Upper Estuary is largely industrial and accessed only with difficulty. Although persons could conceivably contact sediment in the northeastern portion of the Upper Estuary, it is unlikely that a person would be repeatedly exposed to a single location over years or decades. Instead, persons walking along the mudflats would likely range over areas of sediment containing high and low PCB concentrations. In the Ebasco report (Ebasco, 1989), the mean concentrations of PCBs at exposure locations in Area I were 378 ppm for the Upper Estuary, 149 ppm for the Lower Estuary, and 286 ppm for the Cove area. The average sediment concentration calculated by Ebasco for the

Upper Estuary area is above 300 ppm. Since Ebasco derived this number by including sediments from the industrialized, largely inaccessible western side of the Upper Estuary, it is not considered representative of exposures occurring in Area I. The US Army Corps of Engineers plotted PCB sediment concentrations on a probability scale in its investigation of PCB concentrations in the Acushnet River Estuary. On this scale, only 30% of sediments were likely to have PCB concentrations higher than 300 ppm (Figure 2, page 9, USACE, 1989).

2.1.1.2 Areas II and III

PCB concentrations in sediments in Areas II and III were assumed to be 21 ppm and 4 ppm, respectively. These concentrations were reported to be mean concentrations for these areas (Ebasco, 1989).

2.1.2 Human Receptors

2.1.2.1 Areas I and II

Persons who may come in contact with PCBs in sediments in Areas I and II include both older children and adults. The typical adult receptor is assumed to weigh 70 kg. This scenario also assumes that children may also visit the shoreline. It is assumed that a 7 to 16 year old child is representative of children in general. The average weight of a representative child is assumed to be 39.6 kg as calculated from EPA estimates (EPA, 1989). Areas I and II do not contain locations where parents would take children younger than 7 years old, and therefore, this age group was not included as possible receptors.

2.1.2.2 Area III

It was assumed that young children (1-6 years old) in the company of their parents could be exposed to sediments at the beaches in Area III. Therefore, young children, older children, and adults were considered as potential receptors in Area III.

2.1.3 Fraction of Lifetime Exposed

The fraction of a lifetime during which exposure to sediments occurs is assumed to vary with the length of time a person lives in the Greater New

Bedford Harbor Area. Recent investigations by the EPA have shown 9 and 30 years to be the 50th and 90th percentiles, respectively, for time spent at a residence (EPA, 1989). Older children were assumed to be exposed 9 years (age 7 to 16). Younger children (age 1 to 6) were assumed to be exposed for 5 years.

2.1.4 Frequency of Visits

Exposure to sediment was assumed to occur from mid-May to mid-September. Due to limited recreational opportunity, the number of yearly visits to Area I was assumed to be 6 to 18 visits. For Area II, the number of visits was assumed to be 12 or 24 visits. The number of visits assumed to occur in Area III was 18 or 54 visits. In each case, the lower number was considered to be a typical number of visits. A reasonable maximum number of visits is represented by the higher number.

2.1.4 Incidental Ingestion of Sediment as a Route of Exposure to PCB

2.1.4.1 Amount of Sediment Ingested

Ingestion of sediment is assumed to result from incidental hand-to-mouth activity. Unfortunately, soil ingestion has not been studied in a systematic fashion in adults or older children. However, estimates of incidental ingestion of soil range from 1 mg to 100 mg per day for adults and children five years of age and older (Calabrese, 1987 as cited in EPA, 1988). For the purpose of selecting sediment ingestion rates, soil and sediment are assumed to have equal potential for ingestion. For the beachcomber scenario, the older child receptor is assumed to ingest 25 mg of sediment per visit. Since shellfishing may involve greater contact with sediment, the older child shellfisher was assumed to ingest 100 mg of sediment per visit. The adult beachcomber was assumed to ingest 10 mg of sediment per visit. A sediment ingestion rate of 25 mg per visit was assumed for the adult shellfisher. These soil ingestion rates reflect the decreased tendency of adults and older children to ingest soil and are recommended by LaGoy (1987), and EPA (1988a) as soil ingestion rates.

The young child was assumed to ingest 100 mg of soil per visit to Area III. Two studies have examined soil ingestion rates in young children. Binder et al. (1986) used the fecal excretion of aluminum (Al) , silicon (Si), and titanium (Ti) to estimate soil ingestion in 59 children ages 1-3. The arithmetic mean of the soil ingestion values for each child was 108 mg/day. Clausing et al. (1987) determined the fecal excretion of Ti, Al, and acid-insoluble residue (AIR) (used as tracers) in nursery school children (2-4 yr old) and then compared these rates to those of hospitalized children confined to the indoors. In the nursery school children, soil ingestion was calculated to have an arithmetic mean of 105 mg/day, and 49 mg/day in the bedridden children. The authors reasoned that the hospitalized children could not have been directly exposed to soil, and that the contribution to fecal excretion of tracers was posed by non-soil factors such as dust, diet, etc. These factors could be then be subtracted from the values derived for nursery school children to obtain soil ingestion rates. Following such a subtraction, a soil ingestion rate of 56 mg/day was obtained.

Given the results of studies by Binder et al. (1986) and Clausing et al. (1987), it is evident that the EPA recommended soil ingestion rate of 200 mg/day is considerably higher than what a 1-6 year old child is typically expected to ingest. After his review of these studies, LaGoy (1987) suggested that 100 mg/day would be a typical soil ingestion rate for the 1 to 4 year old child. Thus, a sediment ingestion rate of 100 mg/day is used for the young child receptor.

2.1.5 Fraction of PCB Absorbed from Sediment from Ingestion

The oral bioavailability of PCBs from a sand, soil or sediment matrix has not been determined. However, PCBs are structurally and chemically similar to tetrachlorodibenzo-p-dioxin (TCDD), and there is some information available concerning the bioavailability of TCDD in soil. Studies with TCDD indicate that the presence of soil diminishes ingestion bioavailability. Shu et al. (1988a) found that the bioavailability of orally-administered TCDD in Times Beach, Missouri soil was 43% in the rat, compared with a range of 0.5%-85% for soil from other sites. Because of similarities to TCDD in structure, chemistry, and the tendency to strongly adsorb to soil, PCBs are also assumed to have an ingestion bioavailability of 43% (Ao = 0.43). This number is greater than the 30% absorption fraction assumed by the EPA for PCBs in soil (EPA, 1986b) and may therefore be considered a relatively conservative assumption.

2.1.6 Skin Contact with Sediment as a Route of Exposure to PCB

2.1.6.1 Beachcombers-Adult and Older Child

For the beachcombing scenario, only the hands were assumed to be exposed to sediment. For the adult and older child receptor, the hands represent exposed skin areas of approximately 1000 cm^2 and 700 cm^2, respectively.

2.1.6.2 Shellfishers-Adult and Older Child

For the reasonable worst case estimate, it was assumed that contact with sediment will occur as a person wearing shorts walks on the shore or digs in the sediment. Due to the nature of the sediments in Area I, the shellfisher was considered likely to wear shoes. Sediments in Area I were made up of gravel and littered with broken glass and trash (Trip report from Alan Nye). Thus, the feet were not considered to be exposed to sediment. The hands, forearms, and lower legs make up 5.2%, 5.9%, and 12.8% of the total body surface, respectively (EPA, 1989). If the hands, half of the forearms and the front half of the lower leg were to contact the sediment (as might occur when kneeling to dig in sediment), the exposed body surface would be 5.2% (hands), 3.0% (half of the forearms), and 6.4% (front half of the lower legs) for a total of 14.6% (2600 cm^2) of the total body surface of an average adult with a body surface of 18,000 cm^2. An average body surface area for a 7-16 year old child is 12,800 cm^2. Using the same assumptions for exposed body surface as those used for the adult, an exposed body surface of 1900 cm^2 was derived for the child. Thus, for the reasonable worst case scenario, it was assumed that the body surface exposed to sediment for the adult and child receptors were 2600 cm^2 and 1900 cm^2, respectively.

2.1.6.3 Younger Child

The activities of a 1 to 6 year old child at a beach were assumed to involve considerable skin contact with sediment. Regions of the body assumed to contact sediment were the forearms, lower legs, hands, and feet. In the absence of specific data for children, the adult data were used to approximate the percentage of young child's body surface which is exposed to sediment. Using the data reviewed above for adults, the exposed body surface for the young child would be 30.9%. The average total body surface area for a 1 to 6 year old child was calculated to be 6905 cm^2. The average total body surface area was calculated from the 50th percentile values for male and female children ages 2 to 6 years old as listed by the EPA (1989). Given this information, the exposed skin surface of a young child was assumed to be 2100 cm^2.

2.1.7 Amount of Sediment Adhering to Skin

2.1.7.1 Areas I

Estimates of sediment adherence to skin have not been published. However, a range of 0.5 to 1.5 mg/cm^2 has been used for the adherence of soil to skin (EPA, 1984). The upper value of 1.5 mg/cm^2 was used to account for uncertainty in selection of this variable.

2.1.7.2 Areas II and III

Due to the sandy nature of sediments present in Areas II and III, the lower estimate of 0.5 mg/cm^2 was selected to reflect the lower rate of skin adherence of this type of sediment.

2.1.8 Fraction of PCBs in Sediment Absorbed Through the Skin

While PCBs are lipophilic compounds, it can be reasonably expected that binding to sediment will greatly reduce their dermal bioavailability. The dermal bioavailability of PCBs has not been measured from a soil or sediment matrix, but the effect of soil on the dermal bioavailability of tetrachlorodibenzo-*p* -dioxin (TCDD) has been measured in rats. Data by Poiger and Schlatter (1980) indicate that TCDD absorption from a soil paste ranges between 0.05-2% over 24 hours, depending upon the dose. Shu et al. (1988b) determined that TCDD absorption from a soil paste was approximately 1% in 24 hours. In the discussion of their results, Shu et al. recognized the fact that the skin of the rat is more permeable to many chemicals than is human skin, and that a 1% absorption rate of TCDD would probably represent the upper limit of human dermal absorption. Because PCBs are structurally similar to TCDD and have a similar tendency to be strongly sorbed to soil (Chou and Griffin, 1986), a 0.5% dermal absorption per 12 hours is used. A time of 12 hours is used since this is believed to represent a reasonably conservative estimate of the length of time the skin would be in contact with sediment. This value is unlikely to underestimate dermal absorption because:

1) Humans tend to wash before meals, after going to the bathroom, etc., interrupting or terminating dermal absorption.

2) Rat skin is approximately 3-10 times more permeable to lipophilic chemicals than human skin (Bartek, et al., 1972; Wester and Maibach, 1987).

3) In the rat TCDD dermal bioavailability studies, the application site was occluded to prevent interference with absorption. As indicated in 1), this is unlikely to occur in humans.

4) The EPA has adopted a dermal absorption coefficient of 0.005 for its TCDD soil exposure assessment (EPA, 1988b).

Exposure variables discussed in this section are listed in Table 2-1.

Table 2-1
Variables For the Beachcombing/Shellfishing Scenario

Adult receptor

Exposure Variable	Symbol	Beachcomber (Areas I, II, and III)	Shellfisher (Area I only)
Concentration of PCB in sediment	C_s	Area I- 300 ppm Area II- 21 ppm Area III- 4 ppm	Area I- 300 ppm
Body weight	BW	70 kg	70 kg
Years Exposed	YE	9 or 30	9 or 30
Number of exposure events per year	F	Area I-6 or 18 Area II- 12 or 24 Area III-18 or 54	Area I-6 or 18
Amount of soil ingested per exposure event	IR	10 mg	25 mg
Fraction of ingested PCB absorbed	AF_{ing}	0.43	0.43
Exposed skin surface	SA	1000 cm^2	2600 cm^2
Amount of sediment adhering to skin	SC	Area I - 1.5 mg/cm^2 Areas II & III- 0.5 mg/cm^2	Area I - 1.5 mg/cm^2
Fraction of PCB absorbed from skin	AF_{derm}	0.005	0.005

Table 2-1 (continued)

Older Child Receptor (Areas I, II, and III)

Exposure Variable	Symbol	Beachcomber (Areas I, II, and III)	Shellfisher (Area I only)
Concentration of PCB in sediment	C_s	Area I- 300 ppm Area II- 21 ppm Area III- 4 ppm	Area I- 300 ppm
Body weight	BW	39.6 kg	39.6 kg
Years Exposed	YE	9 years	9 years
Number of exposure events per year	F	Area I-6 or 18 Area II- 12 or 24 Area III-18 or 54	Area I-6 or 18
Amount of soil ingested per exposure event	IR	25 mg	100 mg
Fraction of ingested PCB absorbed	AF_{ing}	0.43	0.43
Exposed skin surface	SA	700 cm^2	1900 cm^2
Amount of sediment adhering to skin	SC	Area I - 1.5 mg/cm^2 Area II & III- 0.5 mg/cm^2	Area I - 1.5 mg/cm^2
Fraction of PCB absorbed from skin	AF_{derm}	0.005	0.005

Table 2-1 (continued)

Younger Child Receptor (Area III only)

Exposure Variable	Symbol	Value
Concentration of PCB in sediment	C_s	4 ppm
Body weight	BW	16.3 kg
Years Exposed	YE	5 years
Frequency of visits per year	F	18 or 54
Amount of soil ingested per exposure event	IR	100 mg
Fraction of ingested PCB absorbed	AF_{ing}	0.43
Exposed skin surface	SA	2100 cm^2
Amount of sediment adhering to skin	SC	0.5 mg/cm^2
Fraction of PCB absorbed from skin	AF_{derm}	0.005

2.2 Calculation of PCB Ingestion and Dermal Absorption per Exposure Event

2.2.1 Ingestion of Sediment

The following equation is used to calculate the gastrointestinal absorption of ingested PCB as sediment per exposure event:

$$I_{ing} = (C_s) \times (IR) \times (AF_{ing}) \times (X)$$

where:

I_{ing} is the amount of ingested PCB absorbed per exposure event (µg/exposure event)

C_s is the concentration of 54% or 42% chlorine PCB mixture in sediment (mg PCB/kg soil)
IR is the amount of sediment ingested per exposure event (mg/exposure event)
AF_{ing} is the fraction of PCB absorbed (unitless)
X is a conversion factor (1000 µg/mg)
Y

2.2.2 Dermal Exposure to Sediment

The following equation is used to determine the amount of PCB dermally absorbed from sediment per exposure event:

$$I_{derm} = (C_s) \times (SA) \times (SC) \times (AF_{derm}) \times (X)$$

where:

I_{derm} is the amount of PCB dermally absorbed per exposure event (µg/exposure event)

C_s is the concentration of 54% or 42% chlorine PCB mixture in sediment (mg PCB/mg soil)
SA is the amount of skin surface exposed (cm^2)
SC is the amount of sediment adhering to skin (mg/cm^2)
AF_{derm} is the dermal absorption coefficient for PCBs (unitless)
X is a conversion factor (1000 µg/mg)

2.2.3 Calculation of Total Absorbed PCB Dose Per Exposure Event

The total PCB intake per exposure event is calculated using the equation below:

$$I_{total} = I_{ing} + I_{derm}$$

where:

I_{total} is the total absorbed PCB intake per exposure event (µg/exposure event)

I_{ing} is the amount of ingested PCB absorbed per exposure event (µg/exposure event)

I_{derm} is the amount of PCB dermally absorbed per exposure event (µg/exposure event)

2.3 Calculation of Lifetime Absorbed PCB Dose from Exposure to Sediment

The daily intake of PCB averaged over a lifetime is calculated using the equation:

$$CDI_{sed} = \frac{(I_{total}) \times (F) \times (YE)}{(BW) \times (YL) \times (DY)}$$

where:

CDI_{sed} is the chronic daily intake of PCBs from exposure to sediment (µg/kg/day)

I_{total} is the total absorbed PCB intake per exposure event (µg/exposure event)
F is the frequency of events per year (events/year)
YE is the number of years a person is exposed (years)
BW is the adult body weight (kilograms)
YL is the number of years in a lifetime (years)
DY is a conversion factor (365 days/year)

Using the equations presented in sections 2.2.1 and 2.2.2 and the assumptions presented for the adult beachcomber in Table 2-1, the amount of PCB absorbed for the adult beachcomber per exposure event via ingestion and skin contact with sediment in Area I is calculated below.

$$I_{ing} = \frac{300\ \text{mg}}{1 \times 10^6\ \text{mg}} \times (10\ \text{mg}) \times (0.43) \times \frac{1\text{x}\ 10^3\ \mu\text{g}}{\text{mg}}$$

$$= 1.29\ \mu\text{g/exposure event}$$

$$I_{derm} = \frac{300\ \text{mg}}{1\text{x}\ 10^6\ \text{mg}} \times (1000\ \text{cm}^2) \times \frac{1.5\ \text{mg}}{\text{cm}^2} \times 0.005 \times \frac{1\text{x}\ 10^3\ \mu\text{g}}{\text{mg}}$$

$$= 2.25\ \mu\text{g/exposure event}$$

$$I_{total} = 1.29\ \mu\text{g/exposure event} + 2.25\ \mu\text{g/exposure event}$$

$$= 3.54\ \mu\text{g/exposure event} = \text{the absorbed dose of PCBs per exposure event}$$

The chronic daily absorbed PCB dose is calculated using the equation in section 2.3 and the assumptions presented in Table 2-1 for the typical adult receptor. This calculation is presented below.

$$CDI_{sed} = \frac{(3.54\ \mu\text{g/exposure event}) \times (6\ \text{events}) \times (9\ \text{years})}{(70\ \text{kg}) \times (75\ \text{years}) \times (365\ \text{days/year})}$$

$$= 9.97 \times 10^{-5}\ \mu\text{g/kg/day}$$

The CDI_{sed} is the average lifetime absorbed PCB dose for the adult beachcomber which results from exposure to sediment containing 300 ppm PCB 6 times per year for 9 years.

2.4 Beachcomber/Shellfishing Scenario Exposure Estimates

The absorbed doses of PCB calculated to result from exposure to sediment during beachcombing/shellfishing activities are presented in Table 2-2. Doses are calculated by exposure event as well as by lifetime average.

Table 2-2 Absorbed PCB Doses From Direct Contact With Sediment

Area I: Absorbed PCB Doses for Adult and Older Child Beachcombers and Shellfishers

Receptor	Absorbed PCB Dose/Exposure Event			Lifetime Absorbed Dose			
	Ingested Dose (I_{ing}) (µg/event)	Dermal Dose (I_{derm}) (µg/event)	Total Dose (I_{total}) (µg/event)	6 exposures/yr for 9 years (µg/kg/day)	18 exposures/yr for 9 years (µg/kg/day)	6 exposures/yr for 30 years (µg/kg/day)	18 exposures/yr for 30 years (µg/kg/day)
Adult							
Beachcomber	1.29	2.25	3.54	9.98 E-05	2.99 E-04	3.33 E-04	9.98 E-04
Shellfisher	3.23	5.85	9.08	2.56 E-04	7.67 E-04	4.68 E-04	2.56 E-03
Older Child							
Beachcomber	3.23	1.58	4.80	1.35 E-04	4.06 E-04	-	-
Shellfisher	6.45	4.28	10.7	3.02 E-04	9.07 E-04	-	-

Area II: Absorbed PCB Doses for Adult and Older Child Beachcombers

Receptor	Absorbed PCB Dose/Exposure Event			Lifetime Absorbed Dose			
	Ingested Dose (I_{ing}) (µg/event)	Dermal Dose (I_{derm}) (µg/event)	Total Dose (I_{total}) (µg/event)	12 exposures/yr for 9 years (µg/kg/day)	24 exposures/yr for 9 years (µg/kg/day)	12 exposures/yr for 30 years (µg/kg/day)	24 exposures/yr for 30 years (µg/kg/day)
Adult							
Beachcomber	0.0903	0.0525	0.143	8.05 E-06	1.61 E-05	2.68 E-05	5.37 E-05
Older Child							
Beachcomber	0.226	0.0368	0.263	1.48 E-05	2.96 E-05	-	-

Table 2-2 (continued)

Area III: Absorbed PCB Doses for Adult and Older Child Beachcombers

Receptor	Absorbed PCB Dose/Exposure Event			Lifetime Absorbed Dose			
	Ingested Dose (I_{ing}) (µg/event)	Dermal Dose (I_{derm}) (µg/event)	Total Dose (I_{total}) (µg/event)	18 exposures/yr for 9 years (µg/kg/day)	54 exposures/yr for 9 years (µg/kg/day)	18 exposures/yr for 30 years (µg/kg/day)	54 exposures/yr for 30 years (µg/kg/day)
Adult Beachcomber	0.0172	0.0100	0.0272	2.30 E-06	6.90 E-06	7.67 E-06	2.30 E-05
Older Child Beachcomber	0.0430	0.00700	0.0500	4.23 E-06	1.27 E-05	-	-

Area III: Absorbed PCB Doses for the Young Child

Receptor	Absorbed PCB Dose/Exposure Event			Lifetime Absorbed Dose	
	Ingested Dose (I_{ing}) (µg/event)	Dermal Dose (I_{derm}) (µg/event)	Total Dose (I_{total}) (µg/event)	18 exposures/yr for 5 years (µg/kg/day)	54 exposures/yr for 5 years (µg/kg/day)
Young Child	0.172	0.021	0.193	9.06 E-06	2.72 E-05

3.0 SEAFOOD CONSUMER EXPOSURE SCENARIO

Ingestion of fish and shellfish taken locally represents a potential pathway of PCB exposure for persons of the Greater New Bedford Harbor area. It is well known that PCBs bioaccumulate in fish and shellfish, with certain species such as eel and lobster accumulating relatively greater concentrations than other species. In spite of the potential for PCB exposure from ingestion of locally caught seafood, such exposure is not believed to be an important PCB exposure pathway for the majority of residents in the Greater New Bedford (GNB) Harbor area. The findings of "The Greater New Bedford Harbor PCB Health Effects Study 1984-1987" (GNBHES) indicated that among the "prevalence" group (selected randomly from the GNB populace), the rate of consumption of locally caught fish is quite low and that serum PCB levels are also low. Only 4.2% of the prevalence group was described as catching their own fish.

Using the risk of relatively greater PCB exposure as a selection criterion, the GNBHES also studied a smaller group of persons known as the "enrichment" group. The "enrichment" group contained more persons who reported catching their own fish than the "prevalence" group (35% for the "enrichment" group vs 4.2% for the "prevalence" group). The extent to which local fishermen may violate the Massachusetts Department of Public Health (MDPH) fishing closure order is not known, but it may be assumed that a small group of local fishermen may violate the closure order. It was reasoned that these individuals may experience relatively higher body burdens of PCBs as a result of consumption of fish from the banned areas. However, the authors also concluded that "Almost all individuals who were identified as being at the greatest risk of exposure via contaminated seafood intake, had relatively low serum PCB levels." In spite of the failure to conclusively associate increased consumption of locally caught fish with increased serum PCB levels, the small group of local persons who catch and eat locally caught seafood (assumedly from the closed part of New Bedford Harbor) serve as the representative receptors in the seafood consumer exposure scenario.

3.1 Exposure Variables

Variables for the seafood consumer scenario are listed in Table 3-1 and discussed below.

3.1.1 Human Receptors

Receptors in the seafood consumer scenario were assumed to be an adult weighing 70 kg, an older child (7 to 16 years of age) weighing 39.6 kg, and a younger child (1 to 6 year of age) with an average body weight of 16.3 kg.

3.1.2 Fraction of Lifetime Exposed

As in the beachcombing and shellfishing exposure scenario, the fraction of a lifetime for exposure to fish and shellfish taken from Areas I, II, III, and IV is assumed to vary with the length of time a person lives in the Greater New Bedford Harbor Area. Recent investigations by the EPA have shown 9 and 30 years to be the 50th and 90th percentiles, respectively, for time spent at a residence (EPA, 1989). For the older child, fish consumption was assumed to occur for 9 years (age 7 to 16). The younger child was assumed to be exposed for 5 years (age 1 to 6).

3.1.3 Daily Fish and Shellfish Intake

The GNBHES identified seafood preferences among "prevalence" and "enrichment" groups but apparently did not attempt to quantify fish and shellfish intake. In the absence of information specific to the GNB area, certain assumptions were made regarding seafood intake.

Table 3-1

Exposure Variables for the Seafood Consumer Exposure Scenario

Exposure Variable	Symbol	Adult	Older Child	Young Child
Body weight	BW	70 kg	39.6 kg	16.3 kg
Years Exposed	YE	9 or 30	9	5
Amount of seafood ingested per day	SI	16.3 g or 46.5 g	10.1 g or 26.8 g	6.2 g or 16.5 g
Fraction of seafood from closed areas	FL	0.2 or 0.5	0.2 or 0.5	0.2 or 0.5
Mean PCB concentration in seafood from Areas I, II, III, and IV	C_{sf}	0.369 µg/g (ppm)	0.369 µg/g (ppm)	0.369 µg/g (ppm)

Estimates of fish and seafood consumption vary widely. Although reasons for such wide variation are not completely understood, differences in fish and seafood consumption from one area of the United States to another may be explained by differences in culture or climate.

Javitz (1980) estimated recreational and commercial fish consumption for adults in New England at 16.3 g/day and 46.5 g/day for the mean and upper 95th percentile, respectively. Data specific to children in New England were not available. However, nationwide estimates for the mean and upper 95th percentiles for children aged 0-9 years of age were 6.2 g/day and 16.5 g/day, respectively. Estimates for children aged 10-19 were 10.1 g/day and 26.8 g/day for the mean and 95th percentiles, respectively. The Javitz study was based on surveys conducted twice per month for an entire year.

As discussed by the EPA (EPA, 1989), considerably higher estimates of fish intake have been reported. For example, Puffer (1981, as reported in EPA,

1989) calculated fish intakes for recreational fishermen in Los Angeles, California of 36.9 g/day and 225 g/day for the 50th and upper 90th percentiles, respectively. In another West Coast survey, calculated intake of recreationally caught fish for persons fishing in the Commencement Bay at Tacoma, Washington were estimated to be 23.0 g/day for the 50th percentile and 54 g/day for the upper 90th percentile, respectively. From these studies, it is noteworthy that the highest intake of recreationally caught fish (225 g/day) was estimated from a survey where the climate is mild year round. Due to considerable difference in climate between areas surveyed on the West Coast and the New Bedford Harbor Area, the West Coast studies of recreational fish consumption were not considered applicable to the Greater New Bedford Area. Data derived by Javitz (1980) specific to the New England area were considered more appropriate to estimate fish and shellfish consumption in the Greater New Bedford Harbor Area.

3.1.4 Fraction of Ingested Fish Which is Caught in Closed Areas

There was no quantitative information available to adequately characterize the fraction of the local fishermen's diet which was comprised of seafood caught in the closed areas. Approximately 35% of the "enrichment" group indicated that their primary source of fresh seafood was their own catch but there were no estimates available concerning the amount of seafood consumed. In the absence of specific information, it was assumed that 50% of all seafood ingested by consumers was obtained from their own catch taken from Areas I, II, III, and IV. As a more typical estimate of PCB intake from locally caught fish, separate calculations were made from ingestion of locally caught fish which assumed the year-round fraction of seafood assumed to come from Areas I-IV is 0.20.

3.1.5 Concentration of PCBs in Seafood

Mean concentrations of PCBs in lobster, winter flounder, and clams in Areas I, II, III, and IV are listed below. These values were reported in Ebasco (1989).

	*Lobster (including the tomalley) (ppm)	*Winter flounder (ppm)	*Clam (ppm)
Area			
I	3.8 (7.6)	0.520 (1.039)	0.345 (0.689)
II	1.15 (2.3)	0.189 (0.371)	0.116 (0.231)
III	0.7 (1.4)	0.139 (0.278)	0.078 (0.156)
IV	0.2 (0.4)	0.0505 (0.101)	0.020 (0.039)

*PCB concentrations were decreased by 50% to account for the effect of cooking. Unadjusted values are listed in parenthesis. Humphrey (1976) observed that concentrations of PCBs in uncooked lake trout fillets from Lake Michigan ranged from 3.06 to 11.93 ppm. In contrast, PCB concentrations in cooked lake trout caught in the similar areas of Lake Michigan ranged from 1.03 to 4.67 ppm. Although cooking appears to decrease PCB concentrations 60-70%, a factor of 0.5 (50%) was conservatively used to adjust PCB concentrations downward in cooked lobster, winter flounder, and clams.

Since no one species is likely to adequately represent PCB intake from seafood consumption, a representative mean concentration of PCBs in seafood was calculated as the geometric mean of the above adjusted mean concentrations in lobster, winter flounder, and clams. The geometric mean of these concentrations is 0.324 µg/g (ppm).

Data from Areas I-IV were used to calculate average PCB intake from fish consumption. It is likely that over the extended exposure periods (9-30 years) fish consumption is assumed to occur, fish would be caught in various locations throughout the Greater New Bedford Harbor Area.

3.2 Calculation of Daily PCB Intake from Seafood Consumption

The daily intake of PCBs from ingestion of seafood is calculated using the equation presented below.

$$FI = C_{sf} \times SI \times FL$$

where:

FI is the fraction of PCB ingested per day from seafood consumption (µg/day)

C_{sf} is the average concentration of PCB in seafood (µg/g)
SI is the amount of seafood ingested per day (g/day)
FL is the fraction of all seafood consumed which is obtained from local catch (unitless)

3.3 Calculation of Chron'c Daily PCB Intake from Seafood Ingestion

$$CDI_{sf} = \frac{(FI) \times (YE)}{(BW) \times (YL)}$$

where:

CDI_{sf} is the chronic daily intake of PCBs from seafood ingestion (µg/kg/day)
FI is the fraction of PCB ingested per day from seafood consumption (µg/day)
YE is the number of years a person is exposed (years)
BW is the adult body weight (kilograms)
YL is the number of years in a lifetime (years)

A sample calculation is provided below for the adult receptor in the seafood consumer scenario.

Daily fish consumption for the adult seafood consumer is calculated:

$$FI = 0.369\ \mu g/g \times 16.3\ g/day \times 0.2 =$$

1.20 µg/day of PCB absorbed from seafood consumption

The average lifetime absorbed dose of PCB from eating fish from the closed areas for 9 years is calculated:

$$CDI_{sf} = \frac{(1.20\ \mu g/day) \times (9\ years)}{(70\ kg) \times (75\ years)} =$$

0.00206 µg/kg/day = average lifetime absorbed dose of PCB from seafood

3.4 Seafood Consumer Exposure Estimates

The absorbed doses of PCB for the typical and reasonable worst case seafood consumer are calculated using the assumptions presented in Table 3-1 and the equations presented in sections 3.2 and 3.3. The results are presented in Table 3-2.

Table 3-2

Absorbed PCB Doses from Consuming Seafood from Areas I, II, III, and IV

Receptor	*Average PCB concentration in seafood (ppm)	Average Seafood Consumption (g/day)	Fraction of Total Fish Intake from Areas I-IV	PCB Exposure per Day (μg/day)	PCB Exposure per Day (μg/kg/day)	Years exposed	Average Lifetime Daily Dose (μg/kg/day)
Adult	0.324	16.3	0.2	1.06	1.51E-02	9	1.81E-03
	0.324	16.3	0.5	2.64	3.77E-02	9	4.53E-03
	0.324	16.3	0.2	1.06	1.51E-02	30	6.04E-03
	0.324	16.3	0.5	2.64	3.77E-02	30	1.51E-02
	0.324	46.5	0.2	3.01	4.30E-02	9	5.17E-03
	0.324	46.5	0.5	7.53	1.08E-01	9	1.29E-02
	0.324	46.5	0.2	3.01	4.30E-02	30	1.72E-02
	0.324	46.5	0.5	7.53	1.08E-01	30	4.30E-02
Older Child	0.324	10.1	0.2	0.65	1.65E-02	9	1.12E-03
	0.324	10.1	0.5	1.64	4.13E-02	9	2.80E-03
	0.324	26.8	0.2	1.74	4.39E-02	9	2.98E-03
	0.324	26.8	0.5	4.34	1.10E-01	9	7.44E-03
Younger Child	0.324	6.2	0.2	0.40	2.46E-02	5	3.83E-04
	0.324	6.2	0.5	1.00	6.16E-02	5	9.57E-04
	0.324	16.5	0.2	1.07	6.56E-02	5	1.02E-03
	0.324	16.5	0.5	2.67	1.64E-01	5	2.55E-03

*Geometric mean of mean concentrations of lobster, winter flounder, and clams

4.0 DISCUSSION OF RESULTS

4.1 Beachcombing/Shellfishing Exposure

4.1.1 Area I

Absorbed doses of PCBs due to exposure to affected sediments in Area I during beachcombing and shellfishing were presented in Table 2-2. PCB doses for the adult and older child shellfisher were 2-3 times higher than the beachcomber since it was assumed that a larger amount of body surface would be available for contact with sediment. In addition, it was assumed that the shellfisher would incidentally ingest more sediment. The older child shellfisher was calculated to receive 10.7 μg PCB/exposure event, the highest PCB dose for receptors considered in Area I. The adult shellfisher was calculated to receive an absorbed dose of PCBs of 9.08 μg/exposure event. When considered on the basis of average daily PCB dose over a lifetime, the adult shellfisher exposed 18 times per year for 30 years had the highest dose, 2.56 E-03 μg/kg/day. The older child shellfisher exposed 18 times per year for 9 years was calculated to absorb an average daily lifetime dose of 9.07 E-04 μg/kg/day.

4.1.2 Area II

Absorbed PCB doses in Area II were lower than those calculated for Area I. Unlike Area I, shellfishing was not considered to occur in Area II. Absorbed doses of PCBs per exposure event for beachcombers in Area II were 15 fold less than absorbed amounts calculated for beachcombers in Area II. Absorbed PCB doses per exposure event for adult and older child beachcombers in Area II were 0.143 μg/day and 0.263 μg/day, respectively. The primary factor responsible for the reduction in PCB dose between Areas I and II was the 15 fold difference in PCB concentration in sediments between these areas (300 ppm in Area I vs 21 ppm in Area II). Thus, in spite of the assumption of a greater frequency of contact with sediment in Area II, the maximum lifetime PCB dose for the adult beachcomber in Area II (5.37 E-05 μg/kg/day) was 19 fold less than the dose calculated for the similarly exposed adult beachcomber in Area I (9.98 E-04 μg/kg/day).

4.1.3 Area III

The doses of PCBs due to direct exposure to sediment in Area III were the lowest of the three areas considered. Owing to the accessibility of the beaches in Area III, a young child (1 to 6 years of age) was also considered as a potentially exposed individual. The young child was calculated to have higher absorbed doses of PCBs than the adult or older child. The highest total PCB doses per exposure event were 0.0272 µg/day, 0.0500 µg/day, and 0.193 µg/day for the adult, older child, and young child, respectively. In Area III, the lifetime daily absorbed dose of PCBs was highest for the young child exposed 54 times per year for 5 years. Lifetime absorbed doses for the most highly exposed adult, older child, and young child in Area III were 2.72 E-05 µg/kg/day, 1.27 E-05 µg/kg/day, and 2.30 E-05 µg/kg/day, respectively.

4.2 Seafood Consumer Exposure

Absorbed doses of PCBs due to ingestion of seafood are presented in Table 3-2. Absorbed doses of PCBs calculated for persons consuming locally caught fish and shellfish ranged from 0.46 µg/day for the young child to 8.58 µg/day for the adult. When considered on the basis of body weight, the highest average daily dose is calculated for the child (1.87 E-01 µg/kg/day). If the PCB dose is considered on the basis of lifetime average daily dose, the most heavily exposed adult (an adult consuming an average of 46.5 g of seafood per day for 30 years, 50% of which is from Areas I-IV) is estimated to ingest 4.90 E-02 µg/kg/day. In comparison, the highest lifetime average daily dose calculated to occur from direct contact with sediment was 2.56 E-03 µg/kg/day. This dose was calculated for the adult shellfisher exposed to sediment in Area I 18 times per year for 30 years.

5.0 ANALYSIS OF UNCERTAINTIES

For the beachcombing, shellfishing, and seafood consumer exposure scenarios, there exists uncertainty regarding the degree of exposure to PCBs. In particular, questions remain regarding the frequency of contact with PCBs in sediment, the type of seafood consumed, the frequency of seafood consumption, and the amount of fish consumed from the Acushnet River Estuary and New Bedford Harbor. However, exposure variables and assumptions were selected which were compatible with beachcombing or shellfishing activities in Areas I, II, and III and regional seafood consumption. Where uncertainty existed with regard to frequency and magnitude of exposure, exposure variables were selected such that PCB exposure would not be underestimated. The problems associated with selection of exposure variables which exaggerate PCB exposure were also considered. In particular, exposure variables were selected which would avoid "worst case" exposure estimates and extreme overestimation of risk. The EPA has stated the following concerns over the use of "worst -case" exposure scenarios and the problems associated with exaggeration of risk:

> "A legitimate use of worst-case scenarios is to determine if the exposure or risk is low enough even at this extreme so as to dismiss concern for this scenario. It is not legitimate to use a worst-case scenario to prove that there in fact exists a concern in a real population. In constructing a worst-case scenario, the assessor has usually added assumptions or used particular data points that bring into question whether the scenario actually represents the real world. If the exposure or risk value estimated by a worst-case scenario is high enough to cause concern, the assessor must reevaluate the parameters used and perform reality checks before deciding a problem really exists. It is critical that the results of a worst-case scenario are not immediately applied to an entire population, since in almost all cases this will result in a substantial overestimate of a potential problem." (Proposed Guidelines for Exposure-Related Measurements, 53 Federal Register 48846)

Thus, in the beachcomber, shellfisher, and seafood consumer exposure scenarios, exposure variables were selected which would reasonably represent exposure (and risk) and conservatively represent "real world" conditions.

6.0 REFERENCES

Balsam 1989. PCB Assessment of Acushnet River Upper Estuary Wetland Sediments-New Bedford Harbor. Draft. March 9, 1989.

Binder, S., D. Sokal, and D. Maughan. 1986. Estimating soil ingestion: the use of tracer elements in estimating the amount of soil ingested by young children. Arch. Environ. Health 41:341-345.

Chen, P.H., M.L. Luo, C.K. Wong, and C.J. Chen. 1982. Comparative rates of elimination of some individual polychlorinated biphenyls from the blood of PCB-poisoned patients in Taiwan. Fd. Chem. Toxicol. 20:417.

Clausing, P., B. Brunekreef, and J.H. van Wijnen. 1987. A method for estimating soil ingestion by children. Int. Arch. Occup. Environ. Health 59:73-82.

Ebasco 1989. Draft Final Baseline Public Health Risk Assessment; New Bedford Harbor Feasibility Study. August 1989.

EPA 1984. Risk Analysis of TCDD-Contaminated Soil. Exposure Assessment Group. Office of Health and Governmental Assessment. Washington, D.C. EPA 600/8-84-031.

EPA 1986. Development of Advisory Levels for Polychlorinated Biphenyls (PCBs) Cleanup. Office of Health and Environmental Assessment. Washington, D.C.

EPA 1988a. Superfund Exposure Assessment Manual. April 1988. EPA/540/1-88/001

EPA 1988b. Estimating exposures to 2,3,7,8-TCDD-Draft. EPA 600/6-88/005A. Office of Health and Environmental Assessment.

EPA 1989. Exposure Factors Handbook. Final Report. Office of Health and Environmental Assessment.

Humphrey, H.E.B. 1976. Evaluation of changes of the level of polychlorinated biphenyls (PCB) in human tissue. US Dept.

Javitz, H. 1980. Seafood consumption data analysis. SRI International. Final report prepared for EPA Office of Drinking Water Regulations and Standards. EPA Contract 68-01-3887.

La Goy, P.K. 1987. Estimated soil ingestion rates for use in risk assessments. Risk Analysis 7:355-359.

Lawton, R.W., M.R. Ross, J. Feingold, and J.F. Brown. 1985. Effects of PCB exposure on biochemical and hematological findings in capacitor workers. Environ. Health Perspect. 60:165.

Poiger, H. and C. Schlatter 1980. Influence of solvents and adsorbents on dermal and intestinal absorption of TCDD. Food Cosmet. Toxicol. 18:477-481

Shu, H., D. Paustenbach, F.J. Murray, L. Marple, B. Brunck, D. Dei Rossi, and P. Teitelbaum. 1988a. Bioavailability of soil-bound TCDD: oral bioavailability in the rat. Fund. Appl. Toxicol. 10:648-654

Shu, H., P. Teitelbaum, A.S. Webb, L. Marple, B. Brunck, D.Dei Rossi, F.J. Murray, and D. Paustenbach. 1988b. Bioavailability of soil-bound TCDD: dermal bioavailability in the rat. Fund. Appl. Toxicol. 10:335-343.

USACE (United States Army Corps of Engineers) 1989. New Bedford Harbor Superfund Acushnet River Estuary Engineering Feasibility Study of Dredging and Dredge Material Disposal Alternatives. Report 3. Characterization and elutriate testing of Acushnet River estuary sediment. March 1989

MEMORANDUM

To: File

From: Alan C. Nye, Ph.D.

Concerning: Trip to New Bedford Harbor and Acushnet River Estuary on October 6, 1989

Date: October 12, 1989

TERRA Representatives Present: Robert C. James, Ph.D., Alan C. Nye, Ph.D.

Dr. James and I arrived in the Greater New Bedford Harbor Area on Friday, October 6, 1989 at approximately 9:15 am. After some preliminary planning, Dr. James, Anne Rogers (Nutter, McClennen, and Fish), Leonard Sarapas (Balsam Environmental Consultants), Rick Hughto (Rizzo Associates) and I visited the following locations: The Cove Area and playground on the western shore of the Upper Estuary, the industrialized western shore of the Upper Estuary south of the Wood Street Bridge, Popes Island, the eastern side of the Upper Estuary (Fairhaven side), and the Fort Rodman Beach area. Conditions at the time of the visit were sunny. The temperature was warm enough such that a jacket was not needed.

Observations regarding the Cove Area and playground:
There was no one present in the playground area when we visited. Easy access to the Estuary shore was prevented by a 6 foot high chain link fence. Leonard Sarapas and I were able to scale the fence with some difficulty and make our way through thick underbrush to the shore. The tide was in and the condition of the area was best described as marshy. Little of the shoreline was visible when we visited. Industrial trash and refuse were scattered throughout the underbrush up to the marshy area near the shoreline. The shoreline at this location also smelled of sewage. Paper resembling toilet tissue was stuck to the marsh grass at some locations on the shore.

Impressions:
An older child could conceivably scale the chain link fence and visit the shoreline. However, there is little reason to visit this shoreline. An older child might scale the fence to retrieve a ball that might have been thrown over the fence. However, this activity would not necessarily bring a child in contact with sediments at the shoreline.

There is little reason to believe that an adult would be attracted to the shoreline in the Cove Area. Lack of easy access and the absence of recreational opportunities would make this area relatively unattractive to adults.

Due to the presence of the fence, the shoreline should be considered completely inaccessible to children under the age of six.

For these reasons, the adult and the 0-5 year-old child should not be considered as potential receptors for this area. In summary, these observations provide little justification for consideration of adults and 0-5 year old children as potential receptors in the Cove Area.

<u>Observations regarding the industrialized eastern shore of the Upper Estuary south of the Wood Street Bridge:</u>

No easy access point to the shore was identified on the industrialized western shore of the Upper Estuary. The area visited was south of the Aerovox facility. Easy access to the shoreline was interrupted by bulkheads. This would preclude exposure to sediments for persons of any age.

Impressions:
Persons would not visit the industrialized western shore of the Upper Estuary.

<u>Observations regarding Popes Island:</u>

With the exception of a small park, there were no areas which would provide recreational opportunities. The shoreline of the park area was covered with riprap. Trash and refuse were strewn over much of the riprap. Cars were parked in the area, but no person was seen within 50 feet of the shoreline.

Impressions:
Popes Island provides little in the way of recreational opportunity or inducement to visit the shoreline. There is no reason to suspect that adults or children aged 0-5 years would be exposed to sediments in these areas. The area might be considered as a potential exposure point for older children. However, the chance of any contact with sediment in this location should be considered very remote. Realistically, I see little reason to include this area as a potential point for human contact with sediment.

<u>Observations regarding the eastern side of the Upper Estuary (Fairhaven side):</u>

The eastern side of the Upper Estuary was accessed by walking through the woods near the substation. Paths were observed through wooded areas. Access to the shoreline required approximately 10 minutes of walking and climbing through underbrush. Matted marsh grass was observed throughout the Upper Estuary up to the shoreline. The sediments at this location of the Upper Estuary were pebbly and littered with some trash. There is little reason to think that a person would walk in these sediments with bare feet. No person was seen anywhere near the shoreline of the western side of the Upper Estuary area. Observations from a rock outcropping which afforded good views of most of the Estuary confirmed this fact.

Impression:
The eastern shore of the Upper Estuary was a reasonably pleasant place to visit. However, it would be conservative to assume that an adult or older child would visit this location on a regular basis. This area would not be accessible to a child 0-5 years of age. The "Draft Final Baseline Public Health Risk Assessment; New Bedford Harbor Feasibility Study" indicates that an adult or older child could visit the area 20 or 100 times per year. This number of visits to the eastern shore of the Upper Estuary should clearly be considered excessive. The risk assessment also assumed that a 0-5 year old child could visit the Upper Estuary 1 or 20 times per year. From my observations, this assumption is extremely implausible.

Observations regarding the Fort Rodman Beach area:

The beach at Fort Rodman was easily accessed The beach was sandy but covered with all kinds of trash and broken glass.

Impressions:
The beach was so lacking in aesthetic appeal that it is hard to imagine that anyone would be attracted to the area on a regular basis. Such a site cannot be considered conducive to walking barefooted. The assumption that anyone would wade or swim in this area is questionable at best. It is also extremely unlikely that a 0-5 year old child would be brought to the area to walk along this beach.

The Depositions of Bernard Cambra and David A. Kennedy support the above observations. It is interesting to note from the deposition of Bernard Cambra that in the 30 years that he has lived at the 20 Shawmut Avenue in New Bedford, he has never seen a person fishing in the inner harbor area or bathing or shellfishing in the harbor inside the hurricane dike. Likewise, to the best of his knowledge, David A. Kennedy, a 24 year resident of New Bedford and head of maintenance of recreational facilities in New Bedford, had never seen anyone bathing on the New Bedford or Fairhaven side of the harbor. These observations by long time residents of the Greater New Bedford area clearly serve to question of reality of the assumptions of the "Draft Final Baseline Public Health Risk Assessment; New Bedford Harbor Feasibility Study" which indicate that there is a high level of human contact (20 or 100 times per year) with sediments north of the hurricane barrier.